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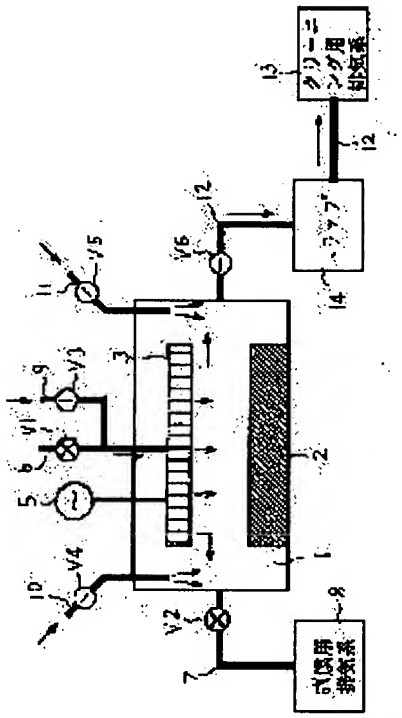
(54) METHOD FOR CLEANING PLASMA ENHANCED CVD SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method capable of rapidly cleaning a plasma CVD system at a low cost.

SOLUTION: The method for cleaning the plasma enhanced CVD system for depositing a desired film on a substrate by vapor phase deposition within a plasma enhanced CVD reaction chamber consists in introducing and blowing inert gas from outside to the dust which contains vapor phase deposited powder or flakes and is un-stably adhered to regions exclusive of the surface of the substrate 4 within the reaction chamber 1, thereby blowing the dust off the dust.



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CLAIMS

[Claim(s)]
[Claim 1] The cleaning approach of the plasma-CVD equipment characterized by to blow away the dust which have adhered to said instability by introducing inert gas from the outside and spraying on a substrate by gaseous-phase deposit in a plasma-CVD reaction chamber to the dust containing the gaseous-phase deposit powder or the flake which clean the plasma-CVD equipment for depositing the desired film , and which be an approach and have adhered unstably in fields other than on said substrate [in said reaction chamber] .
[Claim 2] Said blown-away dust is the cleaning approach of the plasma-CVD equipment according to claim 1 characterized by being discharged out of said reaction chamber by the exhaust air system for cleaning which was prepared separately unlike the exhaust air system for membrane formation used while depositing the film of said request.
[Claim 3] The cleaning approach of the plasma-CVD equipment according to claim 1 or 2 characterized by using nitrogen as said inert gas.
[Claim 4] Said dust is the cleaning approach of plasma-CVD equipment given in one term of claims 1-3 characterized by being dust of the polysilane system which deposited from the membrane formation material gas which contains silane system gas as a principal component, or a silicon system.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the cleaning approach of plasma-CVD equipment especially about the approach a gaseous-phase deposit removes deposit dust [**** / un-] in the gaseous-phase deposit membrane formation equipment for forming membranes on a substrate.
[0002]
[Description of the Prior Art] In current, plasma-CVD equipment is often used, in order to form various thin films. As a typical example, the silicon system thin film needed for the photoconductor drum of a thin film solar cell and an electrophotography copy machine, the TFT array of a liquid crystal display, etc. is formed using plasma-CVD equipment.
[0003] Drawing 3 is illustrating a typical example of plasma-CVD equipment roughly with the typical block diagram. In addition, in each drawing of this application, the same reference number shows the same part or the considerable part. In the plasma-CVD equipment of this drawing 3 , in the plasma reaction chamber 1, the substrate support electrode 2 and the membrane formation material gas blow-off electrode 3 meet mutually, and are arranged. The substrate support electrode 2 connected to the ground supports a substrate 4, and contains the heater for heating the substrate to predetermined temperature. The gas blow-off electrode 3 which has much openings since membrane formation material gas is turned to a substrate 4 and it blows off is electrically connected to RF generator 5 while connecting mechanically to the material gas installation pipe 6 which has a bulb V1. A reaction chamber 1 is decompressed through the exhaust pipe 7 which has a bulb V2 by the exhaust air system 8 for membrane formation.
[0004] In such plasma-CVD equipment, if high-frequency power is impressed from RF generator 5 to the gas blow-off electrode 3, introducing the material gas which contains silane system gas through the material gas installation pipe 6 into the decompressed reaction chamber 1, the plasma P by glow discharge will occur between a substrate 4 and the gas blow-off electrode 3. Material gas decomposes by the plasma reaction, and a desired silicon system thin film may be formed on the substrate 4 heated by predetermined temperature.
[0005]
[Problem(s) to be Solved by the Invention] In the above plasma-CVD equipments, while a desired silicon system thin film is formed on a substrate 4 of a plasma-CVD reaction, it is not avoided that the dust which consists of powder, an amorphous silicon system flake, etc. of a polysilane system [**** / un-] adheres to the front face of RF electrode 3 or the wall of a reaction chamber 1. And when the coating weight of these dust increases with accumulation of membrane formation time amount, the dust which has adhered unstably may separate and fall under the effect of the vibration from the flow and the exhaust air system pump of material gas etc. It separates, and those dust that fell may come flying on a substrate 4, and can cause a defect in a desired silicon system thin film.
[0006] Therefore, when accumulation of the membrane formation time amount of plasma-CVD equipment reaches the specified quantity, generally the equipment is disassembled and cleaned by the

help. In that case, in order to remove certainly not only the dust that has adhered to the RF electrode surface or the reaction chamber wall unstably but the dust which has adhered firmly, mechanical cleaning like sandblasting is also used. Moreover, cleaning which used the alkali solution is also carried out to removal of silicon system dust.

[0007] However, the approach of disassembling and cleaning plasma-CVD equipment by the help in this way also needs a large amount of labor cost while requiring the long duration for disassembly of equipment, cleaning, and assembly.

[0008] Here, the polycrystal silicon photo-electric-conversion layer contained in it in a polycrystal thin film solar cell must be deposited on the thickness of about 3 micrometers from the relation of the light absorption multiplier to being enough if the amorphous silicon photo-electric-conversion layer contained in it in an amorphous thin film solar cell has the thickness of about 0.3 micrometers (refer to JP,11-145499,A). When this manufactures a polycrystal thin film solar cell using plasma-CVD equipment, compared with the case of an amorphous thin film solar cell, the dust which adheres to per one batch of the CVD system in a CVD reaction chamber increases, and the frequency which needs cleaning of a CVD system becomes high.

[0009] Then, cleaning by plasma etching using the mixed gas of CF4 and O2 or ClF3 gas is proposed, without disassembling plasma-CVD equipment (for example, refer to JP,59-142839,A and JP,3-157667,A). Although such plasma etching has the big advantage of not requiring disassembly of the CVD system which should be cleaned, in order to remove adhesion dust by the dry etching reaction, it still needs remarkable reaction time.

[0010] Moreover, the halogenated compound gas generally used for plasma etching is expensive. Furthermore, since halogenated compound gas is generally high gas of harmful nature or flammability in many cases, cost starts the safety equipment for the handling of such etching gas.

[0011] This invention aims at offering the approach of being a short time and cleaning plasma-CVD equipment by low cost in view of the technical problem of the above conventional techniques.

[0012]

[Means for Solving the Problem] According to this invention, the dust adhering to those instability is blown away by introducing inert gas from the outside and spraying to the dust containing the gaseous-phase deposit powder or flake which has adhered unstably in fields other than on a substrate in the approach of cleaning the plasma-CVD equipment for depositing the desired film on a substrate in a reaction chamber, by gaseous-phase deposit in a plasma-CVD reaction chamber.

[0013] Those blown-away dust may be discharged out of a reaction chamber by the exhaust air system for cleaning which was prepared separately unlike the exhaust air system for membrane formation used while depositing the desired film.

[0014] As inert gas, cheap nitrogen may be used preferably. Since it is easy to generate many silicon system dust especially in formation of the silicon system thin film by the plasma CVD using silane system gas, the cleaning approach by this invention may be especially applied preferably, in order to clean the plasma-CVD equipment used for membrane formation of a silicon system thin film.

[0015]

[Embodiment of the Invention] As a more concrete example of the gestalt of operation of this invention, an example is explained below.

[0016] Drawing 1 is illustrating roughly the plasma-CVD equipment used for this example with the typical block diagram. the plasma-CVD equipment of this drawing 1 -- setting -- the equipment of drawing 3 -- in addition, the 1- it has the 3rd cleaning gas installation pipe 9-11, and these pipes 9-11 have bulbs V3-V5, respectively. The 1st cleaning gas installation pipe 9 is connected to the material gas installation pipe 6 between the bulb V1 and the gas blow-off electrode 3, and the 2nd and 3rd cleaning gas installation pipe 10 and 11 is afranged so that gas injection may be carried out in accordance with the side attachment wall in a reaction chamber 1.

[0017] In the plasma-CVD equipment of drawing 1 , the exhaust air system 13 for cleaning for discharging cleaning gas from a reaction chamber 1 through the exhaust pipe 12 which has a bulb V6 is formed further. In addition, since the dust blown away by it is contained in the cleaning gas exhausted

from a reaction chamber 1, it is desirable that the trap 14 for capturing such dust is formed in the middle of an exhaust pipe 12 between a bulb V6 and the exhaust air system 13 for cleaning. Such a trap 12 can be constituted as a cyclone, filters, or those combination.

[0018] In this example, the amorphous silicone film was formed on the substrate 4 using the plasma-CVD equipment of drawing 1 . Where bulbs V3-V6 are closed, the equipment of drawing 1 functions completely like the equipment of drawing 3 , so that I may be understood from drawing 1 . As plasma-CVD conditions for an amorphous silicone film, silane gas and hydrogen gas were used as material gas, substrate temperature is 200 degrees C, and the pressure of a reaction chamber was set as 1330Pa (10Torr). Under such conditions, the polycrystal silicone film with a thickness of about 3 micrometers used for photo-electric-conversion equipment was formed on one substrate 4 of one plasma-CVD membrane formation processing.

[0019] Adhesion of powdery polysilane system dust mainly increased to the wall of a reaction chamber 1, and adhesion of the flake-like dust of amorphous silicon mainly increased to RF electrode 3 as the count of accumulation of such membrane formation processing increased. And after the count of accumulation of membrane formation processing exceeded 40 times (i.e., after accumulation membrane formation thickness exceeded about 120 micrometers), when observing the formed polycrystal silicone film, some pinholes considered to be the traces that dust fell on the substrate were checked with the naked eye.

[0020] Then, as it was shown in drawing 2, cleaning treatment of plasma-CVD equipment was performed. That is, after taking out the substrate which membrane formation processing ended first from a reaction chamber 1, bulbs V1 and V2 were closed and the source of material gas and the exhaust air system 8 for membrane formation were intercepted to the reaction chamber 1, while exhausting a reaction chamber 1 by the exhaust air system 13 for cleaning which bulbs V3-V6 can open after that, and has a big displacement -- the 1- cleaning gas was injected for several minutes into the reaction chamber 1 through the 3rd cleaning gas installation pipe 9-11.

[0021] The dust which had adhered to the wall front face of a reaction chamber 1 or the front face of RF electrode 3 unstably was blown away by injection of such cleaning gas, and it was captured in the trap 14 through the exhaust pipe 12. By the way, in such cleaning, the dust which has adhered to the wall front face of a reaction chamber 1 or the front face of RF electrode 3 firmly cannot be blown away, and cannot perform perfect cleaning. However, the dust which has adhered firmly such does not have a possibility of there being no possibility of almost dropping out from the first, and becoming the cause which introduces a defect into the deposition film on a substrate 4.

[0022] After such cleaning treatment, membrane formation processing of a polycrystal silicone film was performed further many times. In that case, in the polycrystal silicone film with which the count of accumulation of the membrane formation processing after cleaning treatment was formed until about 23 times, i.e., accumulation membrane formation thickness, exceeded about 70 micrometers, a pinhole could not detect with the naked eye. That is, the cleaning gas injection processing for several [only] minutes showed further that it could carry out without introducing the defect in the film for the membrane formation processing to about 70-micrometer built up film thickness, without decomposition-cleaning or dry etching cleaning the interior of plasma-CVD equipment.

[0023] In addition, although N2 cheap gas was used with inactive as cleaning gas in the above-mentioned example, it cannot be overemphasized that other inert gas like Ar may be used. Moreover, the 2nd and 3rd cleaning gas installation pipe 10 and 11 is arranged so that the dust adhering to the side attachment wall in a reaction chamber may be blown away effectively, but if there is a part where dust tends to adhere mostly unstably to others, it cannot be overemphasized that a cleaning gas installation pipe may be arranged also in the neighborhood of it.

[0024]

[Effect of the Invention] As mentioned above, according to the cleaning approach of plasma-CVD equipment of following this invention, the dust which has adhered to the RF electrode or the reaction chamber wall unstably by injection of the cleaning gas for several [only] minutes can be blown away, and it can discharge out of a reaction chamber, namely, it is a short time and plasma-CVD equipment

can be cleaned by low cost.

[0025] Moreover, in the cleaning approach of the plasma-CVD equipment by this invention, since the exhaust air system for cleaning which has a big displacement separately may be prepared, cleaning by gas injection can be carried out to the exhaust air system for membrane formation at a more positive thing, without polluting the exhaust air system for membrane formation between cleaning treatment.

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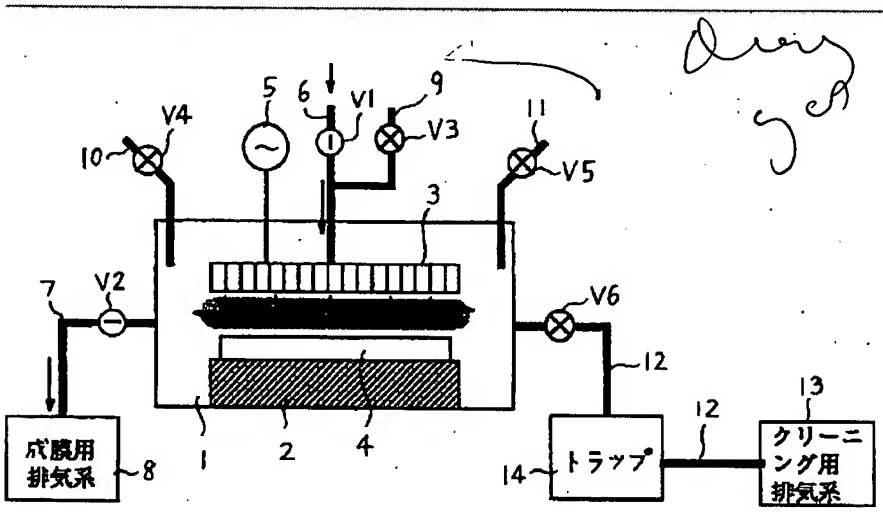
Drawing selection drawing 1



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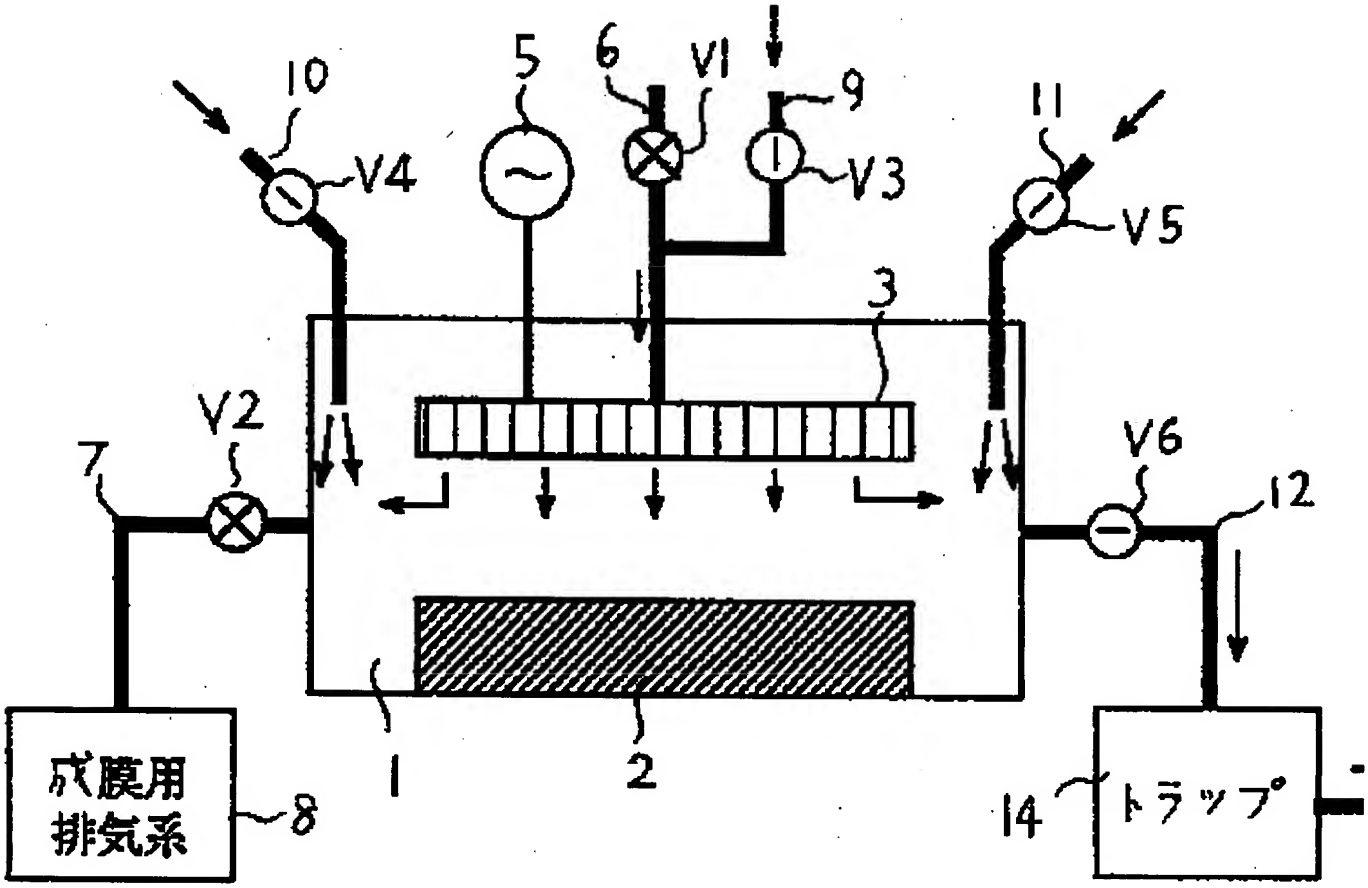
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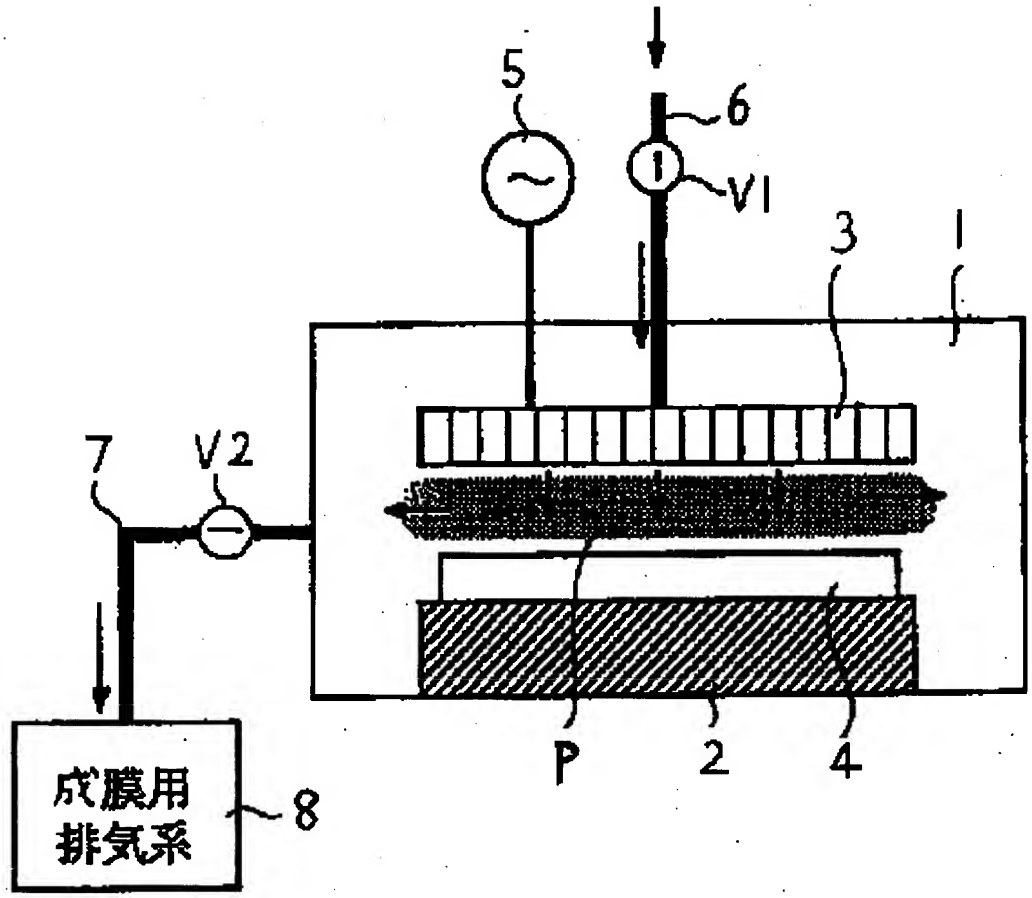
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